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Department of Plant Pathology

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SUMMARY

Except for alfalfa seed originating from a few old fields of Turkestan and Ladak, all varieties and strains now grown for commercial seed production in the United States, so far tested, have proved susceptible to wilt.

All seed lots tested from South America (Chile, Argentina, and Uruguay), Europe (France, Spain, Portugal, Germany, Hungary, Italy, Roumania, and Ukranian S.S.R.), Africa (Morocco, Algeria, and Abyssinia), and Asia (Palestine, Manchuria, China, Korea, and Chinese Turkestan) were found to be susceptible to wilt.

All seed lots of Turkestan origin so far tested are as resistant as Hardistan, or more so. Seed samples from the following districts of Turkestan, in order of combined wilt and cold resistance, ranked thus: Khiva, Chimbai and Alma Ata, Tashkent, Samarkand, and Chardzhui. Seed from the Bukhara, Ashkhabad, and Ferghana districts while wilt resistant lacked sufficient hardiness. Similarly several seed lots from Persia and one from India, although wilt resistant, lack sufficient hardiness.

The Relative Susceptibility of Alfalfas to Wilt

GEORGE L. PELTIER

For the past three years the writer has been testing seed assembled from many alfalfa-growing regions of the world by Mr. H. L. Westover, Senior Agronomist, Division of Forage Crops and Diseases, U. S. Department of Agriculture, for their susceptibility to bacterial wilt (*Aplanobacter insidiosum* L. McC.). The object of this publication is to present the results of these tests and to assign a relative rating to the more promising sorts.

A number of papers on the susceptibility of alfalfas to wilt have appeared within the past three years (1, 3, 5, and 6). All of these are agreed that alfalfa originating from Turkestan is resistant to wilt, as well as Ladak, also of Asiatic origin. Hardistan (2) and Kaw (7), probably strains of Turkestan alfalfa, are considered promising because of their resistance to wilt and cold.

METHODS

Alfalfa plants ranging in age from three weeks to three months have been generally used for the susceptibility tests. All seed was started in the greenhouse, either in plant bands (5), or in flats. The seedlings were carefully lifted and the soil thoroughly washed off the roots before inoculation. They were then transplanted in rows, either in the field in early May or in the greenhouse beds during the winter. Susceptibility tests were conducted in the field during the summers of 1930, 1931, and 1932, and in the greenhouse during the seasons of 1930-31 and 1931-32.

Usually 100 plants of each lot were inoculated, and one month after transplanting a recovery count was made. Once a month thereafter notes were taken on the plants and at the end of five months all plants were lifted and the percentage and severity of infection determined from top and root symptoms. The percentage of infection at the conclusion of the experiments was based on the number of plants living one month after inoculation.

A new isolation of *Aplanobacter insidiosum* was obtained prior to each infection test from diseased alfalfa growing in the field. A two-weeks-old test-tube culture of the organism on potato-lactose agar was placed in one liter of water and the bacterial mass washed from the medium. Two methods of inoculation were employed. With the larger plants the roots were lightly scraped for a distance of one centimeter near the crown with a sharp scalpel while the plants were

held under the bacterial suspension. The ends of the roots of the younger and smaller plants were severed under the suspension with a razor blade upon a block of wood. The latter method is to be preferred, especially with the young plants, since it is more rapid and the plants can be more uniformly inoculated.

EXPERIMENTAL RESULTS

Replications of Grimm and Hardistan were used throughout the wilt tests as inoculated controls, since the one is very susceptible and the other fairly resistant to wilt. The results are reported in Table 1, and serve as a basis for comparison of wilt susceptibility in the many lots of alfalfas tested.

The results obtained from the field tests during the dry summer of 1931 are listed solely to indicate that under such conditions very little wilt developed, even in Grimm, and only an occasional plant of Hardistan became slightly infected. Thus the 1931 tests were of no value for comparisons and have been omitted from the averages. To ameliorate this condition the following season, the plants were watered by means of an overhead system. Sufficient moisture for the rapid growth of the plants and the development of wilt was thus available.

TABLE 1.—*Relative susceptibility of Grimm and Hardistan alfalfa to wilt, in the various tests*

Date and location of tests	Trials	Total plants [1]	Healthy plants	Infected plants	
				Slight	Severe
	Number	*Number*	*Per cent*	*Per cent*	*Per cent*
		GRIMM			
1930 (field)	6	592	5	20	75
1930-31 (greenhouse)	2	102	5	24	71
1931 (field)	10	939	70	23	7
1931-32 (greenhouse)	8	402	4	38	58
1932 (field)	14	633	1	17	82
Average [2]	8	432	4	25	71
		HARDISTAN			
1930 (field)	1	98	65	24	11
1930-31 (greenhouse)	2	103	39	45	16
1931 (field)	1	96	96	4	0
1931-32 (greenhouse)	8	469	40	40	20
1932 (field)	16	641	46	26	28
Average [2]	7	324	47	34	19

[1] The percentage of infection is based on the number of live plants present one month after inoculating and transplanting them in the field or greenhouse.

[2] 1931 field results omitted (see page 4 for explanation).

DOMESTIC ALFALFAS

Ever since wilt investigations were undertaken in Nebraska in 1927, county agents and growers have been sending in seed from old fields in the hope of finding resistant sorts. A number of samples were thus obtained and their susceptibility determined. Samples from seven old fields in Dawson, six in Buffalo, and three in other counties, taken from fields ranging from 15 to 36 years of age, have been grown and tested for wilt susceptibility. All but two have proved to be highly susceptible to wilt. From their growth characters the susceptible lots appeared to be Common alfalfas.

Plants from each of the two resistant samples showed many of the growth characteristics of Turkestan alfalfa, and undoubtedly were previously introduced from Turkestan. Seed from one of these fields has proved not only wilt and cold resistant but productive as well, over a period of years. This alfalfa has recently been named Hardistan (2) because of its hardiness and Turkestan origin. Seed of Hardistan is being increased as rapidly as circumstances permit so that commercial quantities will be available within a few years to growers in Nebraska and other states in the Great Plains area, adapted to its culture. Unfortunately only a small amount of seed was obtained from the second old field and further attempts to get a seed set in this field have failed, so that the only seed now on hand consists of progeny from selfed lines.

A large part of the alfalfa seed grown in Nebraska is raised in Sioux, Dawson, and Sheridan counties in the northwestern part of the state. Many of the fields are old and of unknown origin. It has previously been shown (3) that wilt is a negligible factor in the loss of stands and productivity in this section. In order to determine whether seed from this district was actually resistant to wilt or whether climatic factors were such as to inhibit the spread and development of wilt, seed from six individual fields distributed over this section was tested in comparison with a bulked lot of seed for the commercial trade obtained from the same region.

The tests showed that all six lots were susceptible in slightly varying degrees (Table 2). Apparently the commercial lot was slightly less susceptible, while the percentage of healthy plants from both the individual and the commercial seed lots did not differ greatly from those obtained with Grimm. A higher percentage of slight infection and a lower percentage of severe infection resulted than with Grimm; this distinct difference in severity was characteristic and uniform, not only with northwest-Nebraska seed but also

with other hardy Commons. Under comparable field conditions stands of northwest-Nebraska and other hardy Commons will usually outlast Grimm stands in wilt-infested areas in the Platte River valley.

A number of fields sown to seed from the original Hardistan field have been found in Dawson county and seed from five such fields has been tested. These fields vary in age, but average about 8 to 10 years old. For the most part they still have good, productive stands. Some are isolated, while others are close to other alfalfas; in fact three fields are immediately adjacent to susceptible alfalfas. Seed obtained in 1929 from the original Hardistan field, which was isolated, was planted in 1930 for increase at the North Platte Substation and in northwest Nebraska. Seed samples from these plats were obtained in 1931. Two seed lots from North Platte

TABLE 2.—*Relative susceptibility to wilt of seed from six fields of Common alfalfa and one bulked lot for commercial trade from northwest Nebraska*

Kind of alfalfa	Trials	Total plants[1]	Healthy plants	Infected plants	
				Slight	Severe
	Number	*Number*	*Per cent*	*Per cent*	*Per cent*
Field No. 1	2	138	9	51	40
Field No. 2	2	103	9	44	47
Field No. 3	2	93	5	48	47
Field No. 4	2	98	3	37	60
Field No. 5	2	94	2	52	46
Field No. 6	2	90	1	25	74
Average	2	101	5	43	52
Northwest Nebraska	3	140	12	44	44
Grimm[2]	30	1,729	4	25	71
Hardistan[2]	27	1,311	47	34	19

[1] See footnote, Table 1.
[2] See Table 1.

were obtained, the one grown on the upland near susceptible alfalfas, which were also allowed to set seed, and the second grown in the valley under irrigation adjacent to other alfalfas, which were cut for hay. The field of Hardistan in northwest Nebraska is isolated.

It can be noted from Table 3 that seed from these fields was quite variable in wilt resistance, the percentage of healthy plants ranging from 12 (Field No. 1) to 56 (Field No. 8) per cent, whereas 46 per cent of the plants from the original Hardistan seed were healthy. This variation can be accounted for primarily by the proximity of susceptible alfalfas to these fields. Apparently cross pollination with susceptible alfalfas lowers the resistance of the progeny from the resist-

TABLE 3.—*Relative susceptibility to wilt of seed from eight fields sown to seed from the original Hardistan field in comparison with seed from the original field*

Source of seed		Location	Healthy plants	Infected plants	
				Slight	Severe
			Per cent	*Per cent*	*Per cent*
Original Hardistan field [1]		Dawson county	46	26	28
Fields sown to seed from original Hardistan field [2]	No. 1	Dawson county	12	15	73
	No. 2	Dawson county	14	32	54
	No. 3	Dawson county	17	22	61
	No. 4	N. Platte (up'nd)	30	34	36
	No. 5	Dawson county	33	35	32
	No. 6	N. Platte (valley)	42	47	11
	No. 7	Dawson county	42	27	31
	No. 8	Northwest Nebr...	56	31	13

[1] See Table 1—1932 field tests.
[2] Listed in order of their proximity to fields of susceptible alfalfas.

ant fields, depending on the amount of crossing which has occurred. Seed-increase plats of resistant strains or varieties, therefore, have to be isolated from susceptible alfalfas in order to insure purity.

About a dozen old fields, up to 40 years of age, have been located in the Platte River valley. Unfortunately no seed could be obtained from them; therefore individual plant selections have been made and progenies of selfed selections have been carried on for four generations. The results of this phase of investigations will be presented in a separate publication.

Since the issuance of a preliminary report (5) on wilt susceptibility additional domestic alfalfas have been tested. With few exceptions they have proved to be susceptible. In this group can be included the following alfalfas: Arizona (Maricopa Co.), California F. C. I. 15889,[1] Colorado (La Junta), Idaho F. C. I. 19297, Kansas F. C. I. 15940, New Mexico F. C. I. 15877, New Mexico (Cimarron Co., old field), New Mexico (Eddy Co., old field), New Mexico (Union Co., 42-year-old field, supposedly resistant to wilt), South Dakota F. C. I. 15870, Utah F. C. I. 15815, and Iowa F. C. I. 17399. A supposedly more hardy Grimm (F. C. I. 19291) from New Brunswick, Canada, was also extremely susceptible.

The search for wilt-resistant alfalfas now growing in the United States has therefore narrowed down to a few old fields of Turkestan and Ladak (Table 4). Hardistan and Kaw

[1] The letters F. C. I. and F. P. I. denote, respectively, the accession numbers of the Division of Forage Crops and Diseases, and the Division of Foreign Plant Introduction, Bureau of Plant Industry, U. S. Department of Agriculture.

TABLE 4.—*Relative susceptibility to wilt of a few promising sorts now growing in the United States*

Kind of alfalfa	F.C.I. or F.P.I. accession number	Trials	Total plants [1]	Healthy plants	Infected plants	
					Slight	Severe
		No.	*No.*	*P. ct.*	*P. ct.*	*P. ct.*
Provence (original seed)	34886	2	87	71	13	16
(1931 seed)	34886	2	75	71	23	6
Kaw	.....	2	121	54	20	26
Hardistan [2].....	.....	27	1,311	47	34	19
S. D. (Turkestan)..	19299	3	176	55	21	24
Ladak (S. D.)	14135	3	199	53	23	24
Ladak (Mont.).....	15988	3	138	40	24	36

[1] See Table 1, footnote.
[2] See Table 1.

are examples of alfalfas originating from old fields of Turkestan alfalfa. A third old field, the seed of which is wilt and cold resistant, has been reported from South Dakota (F. C. I. 19299). This field was originally seeded to imported Turkestan. No doubt other old resistant fields of Turkestan can be found in the Great Plains area of the United States, but, as will be shown later, they may not be any more wilt resistant than many recently introduced lots of Turkestan seed.

It is of interest to note that Kaw (7) is derived from plants seeded with the same original seed of Provence (F. P. I. 34886)[2] as that seeded in the varietal plats of the Agronomy Department at the Nebraska Experiment Station in 1922 and reported as resistant by Peltier and Jensen (3) and later by Peltier and Tysdal (5). Remnants of seed from the original lot when tested showed a high resistance to wilt. Seed obtained from these plats in 1931 produced plants with as high a resistance as did the original seed (Table 4). The original and 1931 open-pollinated seed is apparently more resistant than Kaw. Progeny from a number of single-plant selections made in 1927 from these old plats shows a high resistance to wilt.

Ladak, on the basis of three years' tests, can be considered resistant. This variety may find a place in wilt-infested regions naturally adapted to its growth habits. It has been noted in the tests that Ladak (F. C. I. 15988), obtained from Montana, consistently gave a slightly higher percentage of wilt than Ladak (F. C. I. 14135), raised in South Dakota. On inquiry it has been learned that the Ladak seed grown in

[2] Seed was purchased by the Office of Forage Crops and Diseases for Provence alfalfa. A recent examination of the weed seeds contained in the original lot indicates rather definitely that the seed was of Turkestan origin.

Montana, while originating from Ladak F. C. I. 14135 in South Dakota, was obtained from field plats growing adjacent to Grimm and other susceptible sorts.

Except the alfalfas originating from a few old fields of Turkestan and Ladak, all varieties of alfalfa now grown for commercial seed production in the United States and so far tested have proved to be susceptible to wilt. In general the infection and field tests show that nonhardy sorts go out most rapidly, followed by the hardy variegated varieties. Stands of hardy Common alfalfa persist for a longer period than those of Grimm, because usually a lower percentage of severely infected plants is present. The decrease in stands of hardy resistant sorts is relatively slow.

SOUTH AMERICAN ALFALFAS

In all, nine seed lots [3] from Chile, two from Argentina, and one from Uruguay were included in the wilt tests. All lots proved to be as susceptible to wilt as Grimm. For example, the Chilean alfalfas averaged 6 per cent healthy, 26 per cent slightly infected, and 68 per cent severely infected. Previous tests have shown that the Argentina and Peruvian alfalfas were susceptible (3, 5).

EUROPEAN ALFALFAS

Because of the confusion regarding the origin of Provence F. P. I. 34886 [4] (5, 7) it was thought that perhaps wilt-resistant sorts might be found in the alfalfa-growing districts of Provence, France. In all 15 lots collected by Mr. Westover in several of the seed-growing districts of France were included in the wilt tests. Twelve of these proved to be highly susceptible, averaging 4 per cent healthy, 26 per cent slightly infected, and 70 per cent severely infected, practically the same percentage as obtained with Grimm (Table 1). The three remaining lots, though somewhat less susceptible, were not sufficiently so to be considered promising. These results further substantiate the opinion that Provence F. P. I. 34886 did not originate in France.

Sixteen seed lots obtained in the several seed-growing sections of Spain and one from Portugal were tested for susceptibility. The average of all lots showed only 3 per cent healthy and 82 per cent severely infected. Similarly, two lots from Hungary, two from Italy, one from Germany, and one from Roumania all proved to be susceptible to wilt.

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[3] The accession numbers of all lots of seed tested from all sources except the United States are recorded in the appendix.

[4] See footnote, page 8.

Two alfalfas widely grown in the Ukranian S. S. R., the one an acclimatized Grimm, the second a variegated alfalfa, reacted to wilt like Grimm. On the other hand two lots of seed from Trans-Caucasia gave a resistance comparable to some of the Turkestan alfalfas. They may have originally been of Turkestan origin. Of four other lots of seed from the European part of the U. S. S. R., three proved to be susceptible, while the fourth in its resistance and growth habits resembled Turkestan alfalfa. So far as the results show the various seed lots obtained in Europe all proved to be susceptible to wilt, with one or two exceptions. These exceptions resembled Turkestan alfalfa in wilt resistance and growth habits.

AFRICAN ALFALFAS

Twenty-two seed lots originating in Morocco, two from Algeria, and one from Abyssinia were all found susceptible, averaging 4 per cent healthy and 80 per cent severely infected.

ASIATIC ALFALFAS—OTHER THAN TURKESTAN

It has been previously determined (1, 3, 5, and 6) that alfalfa originating in the Turkestan S. S. R. exhibits resistance to wilt. Ladak, a variety of alfalfa described by Westover (8), also had its origin in the foothills of the Himalayas, in India. Therefore additional seed lots from Asiatic countries were tested in the hope of finding other resistant sorts.

A fairly comprehensive collection of alfalfa seed from China, Manchuria, and Korea was procured from the Division of Forage Crops and Diseases for the wilt tests. In all, over 60 seed lots were included. They all proved to be susceptible to wilt. The great majority were as susceptible as Grimm. Only an occasional lot showed 20 to 30 per cent of healthy plants. No seed lot was considered sufficiently resistant for retention as a promising alfalfa. This was even true of several lots originating in Chinese Turkestan. For the most part these alfalfas were short and decumbent and had other undesirable growth characteristics.

A recent introduction from India, F. P. I. 91588, has shown a high resistance to wilt in the 1932 trials. Its resistance to wilt and its growth habits indicate that it may be an especially promising sort. This lot will be given further trials.

Of the ten seed lots from Persia, five proved decidedly resistant, three somewhat so, and two susceptible. The five most resistant sorts were F. P. I. 86353, 86354, 86355, 86356, and 86362. Most of these produced a good leafy growth. From field results they seem rather nonhardy and may not be adapted to Nebraska conditions. Further tests for wilt

and cold resistance are necessary. Two seed lots from Palestine were as susceptible as Grimm to wilt.

TURKESTAN ALFALFAS

A number of miscellaneous seed lots of Turkestan alfalfa were procured in this country when it was first determined that Turkestan seed was resistant to wilt. These lots represented remnants of alfalfa seeded at the Nebraska Station in 1922, on hand in the Division of Forage Crops and Diseases, together with a few samples of Turkestan alfalfa from seed companies. The origin of the seed was, of course, unknown except that it came from Turkestan. It is of interest to note the average resistance of 14 such seed lots and the slight variation in the percentage of infected plants (Table 5). Apparently any Turkestan planting still remaining in Nebraska is resistant to wilt, since the wilt resistance of the above-mentioned seed lots is relatively consistent.

While there are in Turkestan numerous more or less isolated districts that produce varying amounts of seed, the samples collected by Mr. Westover have been grouped by him as coming from nine districts, representative in a general way of the soil and climatic conditions in that country. These districts are: Tashkent, Alma Ata, Ferghana, Khiva, Chimbai, Samarkand, Bukhara, Chardzhui, and Ashkhabad.[5] The first five districts lie north of the fortieth parallel of latitude, the other four to the south. The fortieth parallel of latitude also forms the boundary between Kansas and Nebraska. Roughly speaking, the Chimbai and Alma Ata districts lie in the same latitude as southern North Dakota; Tashkent, Ferghana, and Khiva in the same as northern Nebraska and southern South Dakota; Bukhara, Chardzhui, and Samarkand in the latitude of northern Kansas; while the Ashkhabad district lies in the same latitude as Oklahoma. According to the sparse climatic data available, Turkestan has a climate characterized by rapid and abrupt changes in temperature and a low and variable precipitation with usually a lack of snow cover during the winter — conditions more adverse for alfalfa culture than those prevailing in Nebraska.

In the susceptibility tests, both in the field and greenhouse, seed lots from the Samarkand district have consistently exhibited the highest percentage of resistant individuals and the lowest percentage of severely infected plants (Table 5). Thus from the standpoint of wilt resistance alone, seed from this district rates high. In cold resistance, however, it ranks

[5] Personal letter.

TABLE 5.—*Relative susceptibility to wilt of various lots of alfalfas from several seed-growing districts of Turkestan*

Seed districts	Lots tested	Healthy plants	Standard deviation of a single determination	Infected plants		Standard deviation of a single determination
				Slight	Severe	
	No.	*P. ct.*		*P. ct.*	*P. ct.*	
Miscellaneous Turkestans [1]	14	56	6.16	23	21	3.99
Samarkand	8	78	4.19	16	6	3.48
Tashkent	40	71	10.41	20	9	6.94
Chardzhui	3	61	13.28	30	9	0.15
Alma Ata	8	61	10.05	24	15	5.85
Ferghana	10	58	10.78	30	12	5.53
Bukhara	3	57	11.27	29	14	4.78
Khiva	13	55	9.71	30	15	4.46
Ashkhabad	2	53	20.50	21	26	20.50
Chimbai	8	50	11.91	36	14	3.54
Hardistan [2]	....	47±3.53	.....	34	19±2.10	.....
Grimm [2]	....	4±0.55	.....	25	71±2.95	.....

[1] These miscellaneous samples of Turkestan alfalfa represent former introductions and consisted of remnants of small lots of seed obtained from various sources in the United States. The origin of this seed is unknown except that it came from Turkestan.

[2] See Table 1.

about with Nebraska Common, but considerably lower than Hardistan (5). Under Nebraska conditions alfalfa from this district grows fairly rapidly and is quite uniform and leafy, but in some years the spring growth is quite susceptible to leaf spot (*Pseudopeziza medicaginis* (Lib.) Sacc.), yellow blotch (*Pyrenopeziza medicaginis* Fckl.), and in the fall to rust (*Uromyces medicaginis* Pass.). While the growth characteristics of all lots are fairly uniform, F. P. I. 84388 is apparently outstanding.

The 40 seed lots from the Tashkent district represent 16 different localities including local districts, marts, villages, and individual farms, so that a rather comprehensive test of wilt susceptibility was made of seed grown in this district. In general throughout the various tests, seed lots from this district have consistently ranked a close second to those from Samarkand in wilt resistance. Somewhat larger variations in the resistance of individual lots naturally occurred, since the origin of this seed was more diverse. In cold resistance they ranked somewhat higher than seed from Samarkand and were only slightly less hardy than Grimm (5). Alfalfa from the Tashkent district is, under field conditions, a fairly good grower and quite leafy, but somewhat susceptible to leaf spot, yellow blotch, and rust during some years. While there was

some individual variation in behavior, F. P. I. 86588, 86641, 86445, and 86658 were the most outstanding.

During the spring season of 1929 two carloads of a commercial shipment of Turkestan seed assembled at Tashkent were seeded in the Platte River valley. Two infection tests of this seed lot showed 55 per cent healthy, 24 per cent slightly infected, and 21 per cent severely infected. In the fall of 1932, after a thorough search, wilt-infected individuals could not be found in one such Turkestan field, while an adjacent field of Grimm seeded at the same time was severely infected, approximately only a 50 per cent stand remaining as compared with a perfect stand of Turkestan.

Only three seed lots from the Chardzhui district were tested and naturally a greater variability occurred. When only the percentage of severely infected plants was considered, they ranked with Tashkent alfalfa, but a somewhat lower percentage of healthy plants was reported. In many respects the growth habits and cold resistance of alfalfa from Chardzhui are comparable to those of alfalfa from Samarkand. The most promising lot appears to be F. P. I. 84412. Although the seed lots from Alma Ata show a resistance about like Chardzhui, they had a cold resistance comparable to Grimm (5).

Among the seed lots from the remaining five districts a variation in the percentage of healthy plants of only 8 was found. It is apparent that so far as resistance is concerned there is not much choice between seed from any of these five districts. They do show, however, a much more pronounced difference in cold resistance. Seed lots from Khiva (including Chimbai) had the highest average cold resistance of any alfalfa from Turkestan (5). Seed from Bukhara had a cold resistance somewhat lower than that of Nebraska Common, while seed from Ferghana and Ashkhabad is decidedly lower in hardiness (5).

On the whole the alfalfa from the Chimbai district is fairly good, uniform, and leafy. Perhaps F. P. I. 84430, 84437, and 84443 are the most promising lots. The seed lots from Khiva, on the other hand, produce a more diverse, shorter alfalfa, with more decumbent and slower-growing individuals. No outstanding lot was recognized in the group, although F. P. I. 84420, 84422, 84423, and 84424 appear to be better than the others. All of these lots originated near Kunya-urgench, located midway between the cities of Khiva and Chimbai.

With one or two exceptions the growth habits of the seed lots from the Alma Ata district are somewhat similar to those reported for Tashkent. The two most outstanding lots are F. P. I. 84367 and 86696. No promising seed lots were noted

from either the Bukhara, Ferghana, or Ashkhabad districts. Seed from these localities is rather low in cold resistance and is no more wilt resistant than other hardier alfalfas from other districts, so that seed from these districts is not considered of sufficient merit for further trials in Nebraska.

All individual lots of seed from Turkestan, irrespective of their origin, have proved to be as resistant to wilt as Hardistan, or more so. Peltier and Schroeder (4) have recently pointed out that wilt resistance in Turkestan alfalfa is associated with certain morphological features, particularly in the root, which inhibit rapid development and invasion of the vital tissues by the bacteria. As yet no lot of seed has been found as hardy as Hardistan, although seed from the Khiva district ranks high in cold resistance. For the present it may be stated that seed lots from the Tashkent and Samarkand districts were the most resistant but have a cold resistance akin to that of Nebraska Common. Seed lots from the Khiva, Chimbai, and Alma Ata districts, while slightly less resistant, proved more cold resistant, especially those from the neighborhood of Khiva, although on the whole their growth habits were less promising. Seed lots from the Bukhara, Ferghana, and Ashkhabad districts have shown a lower cold resistance than Nebraska Common and are not recommended for planting in Nebraska.

Field tests for wilt and cold resistance, for susceptibility to leaf spot, yellow blotch, and rust, and for productivity are needed before it can be stated definitely which seed lots are superior and which districts in Turkestan will yield alfalfas best suited to the needs of the growers in Nebraska. Where wilt is a primary factor in rapid decrease of stands, therefore, it is recommended for the present that, when available, Turkestan of known origin be seeded in preference to Grimm and the other highly susceptible sorts.

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APPENDIX

Because of the susceptibility of most seed lots from the various regions of the world, it has been deemed inadvisable to tabulate all of the results. The accession numbers of all seed lots, however, are listed by origin in order that they may be available to investigators. Individual results of the three years' tests are on file and are available from either the Department of Plant Pathology, College of Agriculture, Lincoln, Nebr., or the Division of Forage Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

SOUTH AMERICA

Chile: F.P.I. 38984, 61402, 61735, 88373, 89021, 89022, 89023, 89024, and 89025.
Argentina: F.C.I. 14160 and 15996.
Uruguay: F.P.I. 45494.

EUROPE

France: F.C.I. 12694, 15743, 15744, 15745, 19273, 19274, 19275, and 19276; F.P.I. 81488, 81489, 82601, 82602, 82606, 82609, and 82615.
Spain: F.P.I. 88141, 88143, 88145, 89628, 89629, 89630, 89845, 89846, 89847, 89850, 89858, 89864, 89878, 89880, 89888, and 89897.
Portugal: F.P.I. 89905.
Italy: F.P.I. 85992 and 85994.
Germany: F.C.I. 19272.
Hungary: F.C.I. 14197 and F.P.I. 83725.
Roumania: F.P.I. 81831.
U.S.S.R.: F.P.I. 93238, 92311, 93312, and 93239.
U.S.S.R. (Ukrania): F.C.I. 19305 and 19315.
U.S.S.R. (Trans-Caucasia): F.P.I. 38208 and 51157.

ASIA

Palestine: F.P.I. 30622 and 30623.
China: F.P.I. 31687, 31811, 31812, 31813, 31814, 38464, 40910, 44432, 89111, 89114, 89116, 89117, 89119, 89120, 89121, and 90181.
Korea: F.P.I. 90179 and 90180.
Manchuria: F.P.I. 88968, 88969, 88970, 88973, 88974, 88976, 88978, 88979, 88980, 88982, 88983, 88986, 88987, 88988, 88989, 89041, 89042, 89043, 89044, 89045, 89046, and 90182.
Persia: F.P.I. 86353, 86354, 86356, 86357, 86358, 86359, 86360, 86361, and 86362.
India: F.P.I. 91588.
Turkestan, Miscellaneous Turkestan: Commercial 2230 and 2674, F.C.I. 15754, 15809, 15941, 15942, and Seed Laboratory Import 25392, 25684, 25765, 25878, 25891, 26060, and 26263.
Alma-Ata: F.C.I. 19300, F.P.I. 84361, 84362, 84367, 84371, 84373, 84374, and 86696.
Ashkhabad: F.C.I. 17433 and 19304.

Bukhara: F.C.I. 17432, F.P.I. 84407 and 84409.
Chardzhui: F.P.I. 84412, 84413, and 84414.
Chimbai: F.C.I. 17434, F.P.I. 84429, 84430, 84432, 84435, 84436, 84437, and 84443.
Ferghana: F.C.I. 17431 and 19316, F.P.I. 84380, 84381, 84382, 84383, 84384, 84386, 84402, and 84403.
Khiva: F.C.I. 19303, F.P.I. 84416, 84417, 84418, 84419, 84420, 84422, 84423, 84424, 84426, 84428, 84444, and 84445.
Samarkand: F.C.I. 19301, F.P.I. 84387, 84388, 84389, 84395, 84399, 84400, and 84401.
Tashkent: F.C.I. 19302, F.P.I. 84353, 84354, 84355, 86523, 86524, 86530, 86544, 86549, 86558, 86568, 86570, 86575, 86578, 86580, 86585, 86588, 86612, 86619, 86634, 86639, 86641, 86642, 86643, 86644, 86645, 86646, 86647, 86648, 86649, 86650, 86651, 86652, 86655, 86658, 86660, 86661, 86662, 86663, and 86664.

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